IN THE UNITED STATES PATENT AND TRADEMARK OFFICE BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of:
Fusen Chen, et al.

Serial No.: 08/856,116

Filed: May 14, 1997

For: Reliability Barrier Integration For CU Application

Group Art Unit: 2814

Examiner: G. Peralta

CERTIFICATE OF MAILING
37 CFR 1.8
I hereby certify that this correspondence is being deposited on October 11, 2002 with the United States Postal Service as First Class Mail in an envelope addressed to: Commissioner for Patents, Washington, D.C. 20231.

10/11/02
Date

Signature

Commissioner of Patents
Washington, D.C. 20231

Dear Sir or Madam:

REPLY BRIEF

Applicants, in accordance with 37 C.F.R. §1.193 and M.P.E.P. §1208.02, and in response to the Examiner's Answer dated August 13, 2002, hereby submit this Reply Brief to the Board of Patent Appeals and Interferences.

Although Applicants believe that no fee is due in conjunction with this reply, the Commissioner is hereby authorized to charge any fees necessary to make this reply timely and acceptable, including extension of time fees under 37 C.F.R. §1.136, to Deposit Account No. 20-0782/1931/CPI/COPPER/PJS.

I. THE EXAMINER ERRED IN REJECTING CLAIMS 15-18, 21 AND 23 UNDER 35 U.S.C. § 103(a) BECAUSE THE CITED REFERENCES DO NOT TEACH, SHOW, OR SUGGEST DEPOSITING A FIRST BARRIER LAYER OVER A BLANKET DIELECTRIC LAYER, FORMING A FEATURE THROUGH THE FIRST BARRIER LAYER AND THE DIELECTRIC LAYER TO EXPOSE AN UNDERLAYER, DEPOSITING A SECOND BARRIER LAYER ON THE BOTTOM AND SIDEWALLS OF THE FEATURE, REMOVING THE SECOND BARRIER LAYER FORMED AT THE BOTTOM OF THE FEATURE, AND SELECTIVELY DEPOSITING A METAL LAYER ON THE UNDERLAYER EXPOSED IN THE FEATURE.

The Examiner states that it would have been obvious at the time the invention was made to utilize a barrier layer of titanium nitride as both *Taguchi et al.* and *Zhao et al.* disclose in order to reduce the electromigration of copper and to selectively deposit

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of:
Fusen Chen, et al.

Serial No.: 08/856,116

Filed: May 14, 1997

For: Reliability Barrier Integration For CU Application

Group Art Unit: 2814

Examiner: G. Peralta

CERTIFICATE OF MAILING
37 CFR 1.8
I hereby certify that this correspondence is being deposited on October 11, 2002 with the United States Postal Service as First Class Mail in an envelope addressed to: Commissioner for Patents, Washington, D.C. 20231.

10/11/02
Date

Signature

Commissioner of Patents
Washington, D.C. 20231

Dear Sir or Madam:

REPLY BRIEF

Applicants, in accordance with 37 C.F.R. §1.193 and M.P.E.P. §1208.02, and in response to the Examiner's Answer dated August 13, 2002, hereby submit this Reply Brief to the Board of Patent Appeals and Interferences.

Although Applicants believe that no fee is due in conjunction with this reply, the Commissioner is hereby authorized to charge any fees necessary to make this reply timely and acceptable, including extension of time fees under 37 C.F.R. §1.136, to Deposit Account No. 20-0782/1931/CPI/COPPER/PJS.

I. THE EXAMINER ERRED IN REJECTING CLAIMS 15-18, 21 AND 23 UNDER 35 U.S.C. § 103(a) BECAUSE THE CITED REFERENCES DO NOT TEACH, SHOW, OR SUGGEST DEPOSITING A FIRST BARRIER LAYER OVER A BLANKET DIELECTRIC LAYER, FORMING A FEATURE THROUGH THE FIRST BARRIER LAYER AND THE DIELECTRIC LAYER TO EXPOSE AN UNDERLAYER, DEPOSITING A SECOND BARRIER LAYER ON THE BOTTOM AND SIDEWALLS OF THE FEATURE, REMOVING THE SECOND BARRIER LAYER FORMED AT THE BOTTOM OF THE FEATURE, AND SELECTIVELY DEPOSITING A METAL LAYER ON THE UNDERLAYER EXPOSED IN THE FEATURE.

The Examiner states that it would have been obvious at the time the invention was made to utilize a barrier layer of titanium nitride as both *Taguchi et al.* and *Zhao et al.* disclose in order to reduce the electromigration of copper and to selectively deposit

the copper of the titanium nitride layer as *Zhao et al.* discloses. The Examiner further asserts that the substitution of copper for aluminum, the use of titanium or titanium nitride to improve deposition of a metal layer, and the problem of minimizing polishing steps provide a suggestion and motivation for a selective deposition of copper on a titanium nitride layer. Applicants respectfully traverse this rejection on grounds that the combined references do not suggest the subject matter of the pending claims.

Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). To establish prima facie obviousness of a claimed invention, all the claimed limitations must be taught or suggested by the prior art. *In re Royka*, 490 F.2d 981, 180 USPQ 580 (CCPA 1974).

Taguchi et al. discloses deposition of a first silicon nitride (SiN) layer 21 over a PSG layer 20, etching a contact hole 20a to a silicide layer 17a, depositing a second SiN layer 22 on the silicon nitride layer 21 and the silicide layer 17a, etching the SiN layer 22 so that only the walls of the contact hole 20a are covered with the second silicon nitride layer 22a, depositing a conformal titanium barrier layer on the second silicon nitride layer 22a and the silicide layer 17a in order to provide an improved wetting surface for physical vapor deposition (PVD) aluminum fill of a hole. (See, col. 7, lines 32-63, and Figures 6-11) *Taguchi et al.* teaches the formation of a barrier layer on the bottom of a hole prior to deposition of aluminum and teaches that layers are non-selectively deposited. *Taguchi et al.* does not disclose selectively depositing a metal layer on the underlayer exposed in the feature.

Zhao et al. discloses depositing a interlayer dielectric (ILD) layer 12 over a titanium nitride (TiN) barrier layer 13 disposed on a metal 11, etching the ILD layer 12 to expose the TiN barrier layer 13 (or optionally etching the ILD layer 12 and the TiN barrier layer 13 to expose the metal 11) by a via 15, depositing a dielectric layer 16 over the ILD layer 12 and the exposed portion of TiN layer 12 (or optionally, metal 11) within the via 15, etching the dielectric layer 16 to remove the dielectric layer 16 from the

surface of the ILD layer 12 and the bottom of the via 15 to retain dielectric layer 16 on the sidewalls 17, and depositing an activation layer 21 (or optionally 27) on the exposed bottom of the via 15 prior to depositing a plug 23 by an electroless deposition process. (See, col. 5 line 47, to col. 7, line 35, and Figures 2-6, see also col. 9 line 11, to col. 10, line 28, and Figures 7-13. *Zhao et al.* does not disclose depositing a first barrier layer over a blanket dielectric layer and forming a feature through the first barrier layer and the dielectric layer to expose an underlayer.

Applicants assert that there is no suggestion or motivation to combine *Taguchi et al.*'s conformal titanium barrier layer in order to provide an improved wetting surface for PVD aluminum fill of an opening with *Zhao et al.*'s deposition of an activation layer 21 on the exposed bottom of the via 15 prior to deposit a plug 23 to teach, show or suggest the claimed layer deposition and etching technique, as recited in claim 15, and claims dependent thereon.

Further, the assertion of the Examiner that the interchangeability of materials provides suggestion or motivation of Applicants claimed invention is insufficient to disclose layering techniques. *Taguchi et al.* is directed to forming a silicon nitride layer to prevent oxidation of a titanium barrier layer for formation of a titanium silicide or a titanium and aluminum/silicon interface for deposition of a PVD aluminum layer. *Zhao et al.* is directed to forming a silicon nitride layer to prevent copper diffusion and to promote electroless deposition and fill by metal activation from metal layer, such as titanium nitride, exposed at the bottom of a feature.

Thus, the suggestion of using silicon nitride and titanium/titanium nitride layers as barrier layers for metals, reducing polishing steps for copper features, and that copper is preferably used instead aluminum, does not teach, show, or suggest depositing a first barrier layer over a blanket dielectric layer, forming a feature through the first barrier layer and the dielectric layer to expose an underlayer, depositing a second barrier layer on the bottom and sidewalls of the feature, removing the second barrier layer formed at the bottom of the feature, and selectively depositing a metal layer on the underlayer exposed in the feature.

Further, with regard to dependent claim 18, *Zhao et al.* and *Taguchi et al.* disclose reactive ion etching for anisotropic etching of a barrier layer and in contrast, the

claimed invention uses a sputter etching technique to remove materials, and would not suggest or motivate the layering and etching process steps as recited in claim 15, and claims dependent thereon.

Regarding dependent claim 21, *Zhao et al.* discloses that copper is a superior material for forming semiconductor features, but that copper material properties, such as difficulty to etch and greater diffusion characteristics over aluminum, require copper features to be formed different, such as encapsulation barriers for dielectric and other metals including aluminum, as well as be deposited using other techniques, such as selective electroless copper deposition compared to more conventional PVD deposition of aluminum. Thus, *Zhao et al.'s* preference of copper to aluminum would not suggest or motivate the layering and etching process steps as recited in claim 15, and claims dependent thereon.

Regarding dependent claim 23, *Sliwa et al.* discloses the use of sidewall spacers of a conductive material on an aluminum interconnect to improve oxide planarization and inhibit whisker formation and voiding due to electromigration in aluminum interconnect formation. *Sliwa et al.*, does not add to *Taguchi et al.* and *Zhao et al.*, to disclose the layering and etching process steps as recited in claim 15, and claims depndent thereon.

Therefore, the combination of *Taguchi et al.*, *Zhao et al.*, and *Sliwa et al.*, alone or in combination, do not teach, show, or suggest depositing a first barrier layer over a blanket dielectric layer, forming a feature through the first barrier layer and the dielectric layer to expose an underlayer, depositing a second barrier layer on the bottom and sidewalls of the feature, removing the second barrier layer formed at the bottom of the feature, and selectively depositing a metal layer on the underlayer exposed in the feature, as recited in claim 15, and claims dependent thereon. Reversal of the rejection of claims 15-18, 21, and 23 is respectfully requested.

Conclusion

In conclusion, the references do not teach, show, or suggest depositing a first barrier layer over a blanket dielectric layer, forming a feature through the first barrier layer and the dielectric layer to expose an underlayer, depositing a second barrier layer

on the bottom and sidewalls of the feature, removing the second barrier layer formed at the bottom of the feature, and selectively depositing a metal layer on the underlayer exposed in the feature. Thus, Applicants respectfully request reversal of the rejection of claims 15-18, 21, and 23.

Respectfully submitted,

Brian K. Hrna
Registration No. 41,852
MOSER, PATTERSON & SHERIDAN, L.L.P.
3040 Post Oak Blvd., Suite 1500
Houston, TX 77056
Telephone: (713) 623-4844
Facsimile: (713) 623-4846
Attorney for Applicant(s)

T:\Clients\APPM\1000-1999\1931\PTO\1931_Reply Brief 081302.doc